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BY: Sheryl R. Neumann DATE: October 2, 2001

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re:	Patent Application of Noboru HIGASHI *et al.*	: Grout Art Unit: Not Yet Assigned
Conf. No.:	7117	: Examiner:
Appln. No.:	09/916,181	: Group Art Unit: Not Yet Assigned
Filed:	July 26, 2001	:
For:	METHOD FOR INSPECTION OF CIRCUIT BOARDS AND APPARATUS FOR INSPECTION OF CIRCUIT BOARDS	: Attorney Docket : No. **8861-413US** : **(P26315-01)**

PRELIMINARY AMENDMENT

Simultaneously with the filing of the above-identified application with which this Preliminary Amendment is being filed, and prior to the calculation of the filing fee, Applicant hereby amends the application as follows, without prejudice:

In the Claims:

Please amend the claims as follows:

Please delete the CLAIMS section and replace it with the new CLAIMS section, shown in clean form attached hereto, having the bracketed additions and stricken deletions as shown in the attached marked-up version.

REMARKS

Claims 1 to 18 are pending in the application.

The purpose of this amendment is to place the claims in appropriate U.S. form and delete the multiple dependent claims in this application, and thereby eliminate excessive claim fees. Such amendments are formal in nature and no new matter is added by any of the

above amendments. A Substitute Claims Section is enclosed to reflect these amendments. Entry of this amendment and early examination of this application are respectfully solicited.

Respectfully submitted,

NOBORU HIGASHI ***et al.***

10/2/01 (Date)

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Enclosure

SUBSTITUTE CLAIMS SECTION

CLAIMS

We claim:

1. A method for inspection of circuit boards comprising:

process of measuring surface-shape of a circuit board on which inspection objects are placed;

approximated curved surface generation process for generating an approximated curved surface which is an estimated surface-shape of the circuit board, on which no inspection object is placed, from measured surface-shape data;

process of subtracting said approximated curved surface generated from the measured surface-shape data;

ROI determination process of determining regions which are different from the approximated curved surface in accordance with the data obtained by said subtraction process; and

process of inspecting whether electronic parts placed on said circuit board and connecting materials for connecting electronic parts are in a desired state or not.

2. A method for inspection of circuit boards according to claim 1, wherein said approximated curved surface generation process comprises:

histogram generation process in which measured data of the surface-shape of the circuit board are divided into small regions and a histogram in the measured data of the surface-shape of the respective divided regions is generated,

circuit board height determination process for determining values of the circuit board heights at predetermined particular coordinate points in respective divided regions from the generated histogram, and

process in which the height values at other coordinate points than said coordinate points at which the circuit board height values were determined are determined by an interpolation process using already determined height values, and thereby an approximated curved surface of the circuit board is generated.

3. A method for inspection of circuit boards according to claim 2, wherein

said histogram generating process comprises:

process of measuring the reflected light amount from the circuit board,

process of determining those regions that show a light amount of a particular intensity in measured reflected light amount data, and

process of generating a histogram of the surface-shape data of particular regions using only those determined regions showing a particular intensity light amount.

4. A method for inspection of circuit boards according to claim 2, wherein said histogram generating process comprises:

process of measuring the color information of the circuit board, and

process of generating a histogram of the surface-shape data of particular regions using only those regions showing a particular color information in the measured color information.

5. A method for inspection of circuit boards according to claim 2, wherein said histogram generating process comprises process of generating a histogram of the surface-shape data of particular regions using only those particular regions in a CAD data of the circuit board.

6. A method for inspection of circuit boards according to claim 3, wherein said region determination process comprises:

process of generating a histogram in the reflected light amount data,

process of determining a threshold value by which the histogram regions are divided from the generated histogram,

process of region-dividing the reflected light amount data by the determined threshold value, and

process of determining the regions of a particular light amount data from among divided regions.

7. A method for inspection of circuit boards according to claim 2, wherein said circuit board height determination process determines the maximum values of the

histograms as the height values of the circuit board.

8. A method for inspection of circuit boards according to claim 2, wherein said circuit board height determination process calculates approximated curves of the histograms and determines its maximum values as circuit board height values.

9. A method for inspection of circuit boards according to claim 2, wherein, in process for getting the height values of the whole surface of the circuit board by said interpolation process, the whole surface of the circuit board is approximated by a curved surface by a higher-order interpolation process, and this is determined as an approximated curved surface of the circuit board.

10. A method for inspection of circuit boards according to claim 1, wherein, in said approximated curved surface generating process, a curved surface as a new approximated curved surface is obtained by adding an offset value to the generated approximated curved surface, then the subtraction process is performed by using this approximated curved surface.

11. A method for inspection of circuit boards according to claim 1, wherein, in said ROI determination process, calculating areal value of respective ROI obtained by said subtraction process, only the areal that is in a predetermined range are determined as the ROI.

12. A method for inspection of circuit boards according to claim 1, wherein said ROI determination process comprises process of reduction and expansion, as well as eliminating minute regions with respect to respective ROI obtained by said subtraction process.

13. A method for inspection of circuit boards according to claim 1, wherein ROI determination process comprises:

process for expanding the ROI, process of separating the expanded ROI to a ROI and a board surface region, and process of performing the inspection for the separated ROI.

14. A method for inspection of circuit boards according to claim 1, wherein the ROI determined in said ROI determination process is made to be a teaching data which set an inspection reference.

15. A circuit board inspection apparatus comprising:

a measuring section for measuring data of a surface-shape of a circuit board on which inspection objects are placed;

an approximated curved surface generating section for generating an approximated curved surface which is estimating surface-shape of the circuit board on which no inspection object is placed;

a subtraction section for subtracting the generated approximated curved surface from the measured surface-shape data;

an inspection objective-area determination section for determining regions which are different from the approximated curved surface as ROI in accordance with the data obtained in said subtraction process; and

an inspection sections for inspecting whether said electronic parts placed on the circuit board as well as connecting materials for connecting electronic parts are in a desired state or not, with respect to the determined ROI.

16. A circuit board inspection apparatus according to claim 15, wherein said approximated curved surface generation section comprises:

a histogram generation processing section in which measured data of the surface-shape of the circuit board are divided into small regions and a histogram in the measured data of the surface-shape of the respective divided regions is generated,

a circuit board height determination section for determining the circuit board heights at predetermined particular coordinate points in the respective divided regions from the generated histogram, and

a processing section in which the height values at other coordinate points than said coordinate points at which the circuit board height values were determined are determined by an interpolation process using already determined height values, and thereby an approximated curved surface of the circuit board is generated.

17. A circuit board inspection apparatus according to claim 16, wherein said histogram generating processing section comprises; a processing section for measuring the reflected light amount from the circuit board,

a region determination processing section for determining those regions that show a light amount of a particular intensity in measured reflected light amount data, and

a processing section for generating a histogram of the surface-shape data of particular regions using only those particular regions showing a particular intensity light amount.

18. A circuit board inspection apparatus according to claim 16, wherein said histogram generating processing section comprises:

a processing section for measuring the reflected light amount from the circuit board, and

a processing section for generating a histogram of the surface-shape data of the particular regions using only those regions showing a particular color information in the measured color information.

MARKED-UP VERSION OF SUBSTITUTE CLAIMS SECTION

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}CLAIMS

[We claim:]

1. A method for inspection of circuit boards comprising:

process of measuring surface-shape of a circuit board on which inspection objects are placed;

approximated curved surface generation process for generating an approximated curved surface which is an estimated surface-shape of the circuit board, on which no inspection object is placed, from measured surface-shape data;

process of subtracting said approximated curved surface generated from the measured surface-shape data;

ROI determination process of determining regions which are different from the approximated curved surface in accordance with the data obtained by said subtraction process; and

process of inspecting whether electronic parts placed on said circuit board and connecting materials for connecting electronic parts are in a desired state or not.

2. A method for inspection of circuit boards according to claim 1, wherein said approximated curved surface generation process comprises:

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histogram generation process in which measured data of the surface-shape of the circuit board are divided into small regions and a histogram in the measured data of the surface-shape of the respective divided regions is generated,

circuit board height determination process for determining values of the circuit board heights at predetermined particular coordinate points in respective divided regions from the generated histogram, and

process in which the height values at other coordinate points than said coordinate points at which the circuit board height values were determined are determined by an interpolation process using already determined height values, and thereby an approximated curved surface of the circuit board is generated.

3. A method for inspection of circuit boards according to claim 2, wherein said histogram generating process comprises:

process of measuring the reflected light amount from the circuit board,

process of determining those regions that show a light amount of a particular intensity in measured reflected light amount data, and

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~~}~~process of generating a histogram of the ~~{~~

~~}~~surface-shape data of particular regions using only those determined regions showing a particular intensity light amount.

4. A method for inspection of circuit boards according to claim 2 ~~{or claim 3}~~, wherein said histogram generating process comprises:

process of measuring the color information of the circuit board, and

process of generating a histogram of the surface-shape data of particular regions using only those regions showing a particular color information in the measured color information.

5. A method for inspection of circuit boards according to ~~{either one}~~ claim ~~{from claim 2 to claim 4}~~ **[2]**, wherein said histogram generating process comprises process of generating a histogram of the surface-shape data of particular regions using only those particular regions in a CAD data of the circuit board.

6. A method for inspection of circuit boards according to **[claim 3]** ~~{either one claim from claim 3 to~~

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~~claim 5}~~, wherein said region determination process ~~{~~

~~}~~comprises:

process of generating a histogram in the reflected light amount data,

process of determining a threshold value by which the histogram regions are divided

from the generated histogram,

process of region-dividing the reflected light amount data by the determined threshold value, and

process of determining the regions of a particular light amount data from among divided regions.

7. A method for inspection of circuit boards according to ~~{either one}~~ claim ~~{from claim 2 to claim 6}~~ **[2]**, wherein said circuit board height determination process determines the maximum values of the histograms as the height values of the circuit board.

8. A method for inspection of circuit boards according to ~~{either one}~~ claim ~~{from claim 2 to claim 7}~~ **[2]**, wherein said circuit board height determination process calculates approximated curves ~~{~~

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~~}~~of the histograms and determines its maximum values as ~~{~~

~~}~~circuit board height values.

9. A method for inspection of circuit boards according to ~~{either one}~~ claim ~~{from claim 2 to claim 8}~~ **[2]**, wherein, in process for getting the height values of the whole surface of the circuit board by said interpolation process, the whole surface of the circuit board is approximated by a curved surface by a higher-order interpolation process, and this is determined as an approximated curved surface of the circuit board.

10. A method for inspection of circuit boards according to ~~{either one}~~ claim ~~{from claim 1 to claim 9}~~ **[1]**, wherein, in said approximated curved surface generating process, a curved surface as a new approximated curved surface is obtained by adding an offset value to the generated approximated curved surface, then the subtraction process is performed by using this approximated curved surface.

11. A method for inspection of circuit boards according to ~~{one claim from claim 1 to claim 10}~~ **[claim 1]**, wherein, in said ROI determination process, calculating areal

value of respective ROI obtained by ~~{~~

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~~}~~said subtraction process, only the areal that is in a ~~{~~

~~}~~predetermined range are determined as the ROI.

12. A method for inspection of circuit boards according to ~~{either one claim from claim 1 to claim 11}~~ **[claim 1]**, wherein said ROI determination process comprises process of reduction and expansion, as well as eliminating minute regions with respect to respective ROI obtained by said subtraction process.

13. A method for inspection of circuit boards according to ~~{either one claim from claim 1 to claim 12}~~ **[claim 1]**, wherein ROI determination process comprises:

process for expanding the ROI, process of separating the expanded ROI to a ROI and a board surface region, and process of performing the inspection for the separated ROI.

14. A method for inspection of circuit boards according to ~~{either one claim from claim 1 to claim 13}~~ **[claim 1]**, wherein the ROI determined in said ROI determination process is made to be a teaching data which set an inspection reference.

15. A circuit board inspection apparatus comprising:

~~{-42-~~

~~}~~a measuring section for measuring data of a ~~{~~

~~}~~surface-shape of a circuit board on which inspection objects are placed;

an approximated curved surface generating section for generating an approximated curved surface which is estimating surface-shape of the circuit board on which no inspection object is placed;

a subtraction section for subtracting the generated approximated curved surface from the measured surface-shape data;

an inspection objective-area determination section for determining regions which are different from the approximated curved surface as ROI in accordance with the data obtained in

said subtraction process; and

an inspection sections for inspecting whether said electronic parts placed on the circuit board as well as connecting materials for connecting electronic parts are in a desired state or not, with respect to the determined ROI.

16. A circuit board inspection apparatus according to claim 15, wherein said approximated curved surface generation section comprises:

a histogram generation processing section in which measured data of the surface-shape of the {

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}circuit board are divided into small regions and a {

}histogram in the measured data of the surface-shape of the respective divided regions is generated,

a circuit board height determination section for determining the circuit board heights at predetermined particular coordinate points in the respective divided regions from the generated histogram, and

a processing section in which the height values at other coordinate points than said coordinate points at which the circuit board height values were determined are determined by an interpolation process using already determined height values, and thereby an approximated curved surface of the circuit board is generated.

17. A circuit board inspection apparatus according to claim 16, wherein said histogram generating processing section comprises; a processing section for measuring the reflected light amount from the circuit board,

a region determination processing section for determining those regions that show a light amount of a particular intensity in measured reflected light amount data, and

~~{ 44~~

}a processing section for generating a {

}histogram of the surface-shape data of particular regions using only those particular regions showing a particular intensity light amount.

18. A circuit board inspection apparatus according to claim 16 ~~{or claim 17}~~, wherein said histogram generating processing section comprises:

a processing section for measuring the reflected light amount from the circuit board, and

a processing section for generating a histogram of the surface-shape data of the particular regions using only those regions showing a particular color information in the measured color information.